SOLAR DESIGN GUIDELINES FOR SUBDIVISIONS AND PLANNED RESIDENTIAL DEVELOPMENTS

3/15/85

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SOLAR DESIGN GUIDELINES FOR SUBDIVISIONS AND
PLANNED RESIDENTIAL DEVELOPMENTS

PURPOSE AND INTENT

The purpose of these guidelines is to assist architects and site planners in designing subdivisions and planned residential developments which are sensitive to the natural solar heating and cooling opportunities present on a site and to encourage the use of both passive and active solar systems through compatible siting techinques.

It is the intent of these guidelines to provide the information necessary to develop subdivisions and planned residential developments which comply with Section 66473.1 of the State Subdivision Map Act. Additionally, these guidelines are intended to preserve the full range of options available for compliance with the State Title 24 residential energy efficiency standards.

It is important to note that the protection of solar energy opportunities represents only one component of subdivision design. Many other environmental factors such as slope stability, erosion protection, open space preservation, and aesthetic enhancement must also be taken into consideration. For this reason the following guidelines establish priorities for reducing potential conflicts between passive solar objectives and other environmental considerations.

Solar Rights Act of 1978

The California Solar Rights Act adds Section 66473.1 to the State Subdivision Map Act which states that "The design of a subdivision for which a tentative map is required shall provide, to the extent feasible, for future passive or natural heating or cooling opportunities in the subdivision. Section 66473.1 goes on to state that:

"Examples of passive or natural heating opportunities in subdivision design, include design of lot size and configuration to permit orientation of a structure in an east-west alignment for southern exposure. (Emphasis added.)

Examples of passive or natural cooling opportunities in subdivision design include design of lot size and configuration to permit orientation of a structure to take advantage of shade or prevailing breezes.

In providing for passive or natural heating or cooling opportunities in the design of a subdivision, consideration shall be given to local climate, to contour, to configuration of the parcel to be divided, and to other design and improvement requirements . . ."

The Solar Rights Act also enables the legislative body of a City or County upon adoption of an ordinance, to require, as a condition of approval of a tentative map, the dedication of solar easements.

The guidelines contained in this manual are designed to clarify what shall be encouraged, in the City of San Diego, to protect "natural heating and cooling opportunities" in new subdivisions and planned residential developments.

Title 24 - Residential Energy Building Standards

The California Administrative Code, Title 24 (Energy Conservation in New Building Construction) requires that new residential buildings be designed to meet energy performance standards for space conditioning and water heating.

The energy performance standards can be met through compliance with a variety of prepackaged formulas adjusted to specific climate zones. These formulas range from complete emphasis on the use of efficient energy systems coupled with higher insulation requirements to the use of both active and passive solar techniques.

Additionally, developers may demonstrate compliance with the Title 24 energy budget through a "point system" or computer analysis certified by the State. This approach provides maximum design flexibility.

Although Title 24 requirements do not address subdivision design, the effectiveness of passive solar options depends on the availability of adequate solar access. Unless provisions are made to protect solar access during the subdivision and site plan review process the feasibility of some Title 24 options cannot be assured.

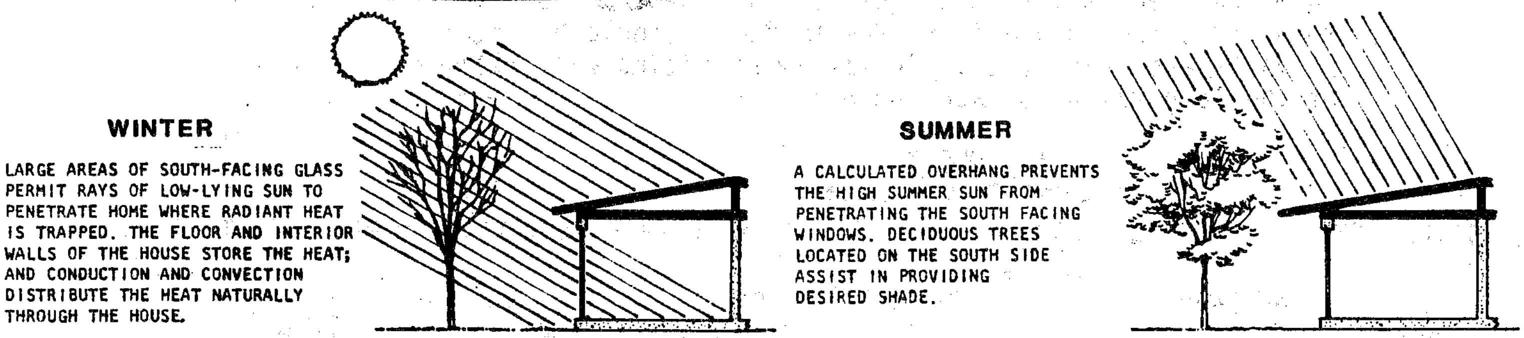
Passive Solar Design

Passive solar design is often defined as the utilization of solar energy without the aid of mechanical components. This is in contrast to "active" solar systems which rely on fans, pumps, storage tanks etc. Both require access to direct sunlight.

A more relevant definition of passive solar design for the purposes of these guidelines is that in passive systems the essential functions of collection, storage, and distribution of solar heat are performed by the building components themselves. A window for example, may act as a solar collector while a wall or concrete slab may store solar heat. The principal function of passive solar systems is space conditioning. The basic concept, used in direct gain passive solar systems, is illustrated below:

(FIGURE 1)

BASIC DIRECT GAIN PASSIVE SOLAR CONCEPT



Indirect gain passive solar systems (not shown) are also available.

An explanation of the various techniques and technical data for designing passive solar buildings is beyond the scope of this manual. However, many excellent resource books are available on this subject including "The Passive Solar Design Manual for San Diego County" prepared for the County of San Diego Department of Planning and Land Use.

From a land use perspective the decision to incorporate passive solar systems has important implications for subdivision design. Passive solar systems require a higher level of solar access than almost any other solar application. As a corollary feature, a subdivision or planned development site which is designed to preserve this level of access will be able to accommodate almost all other solar systems both passive and active.

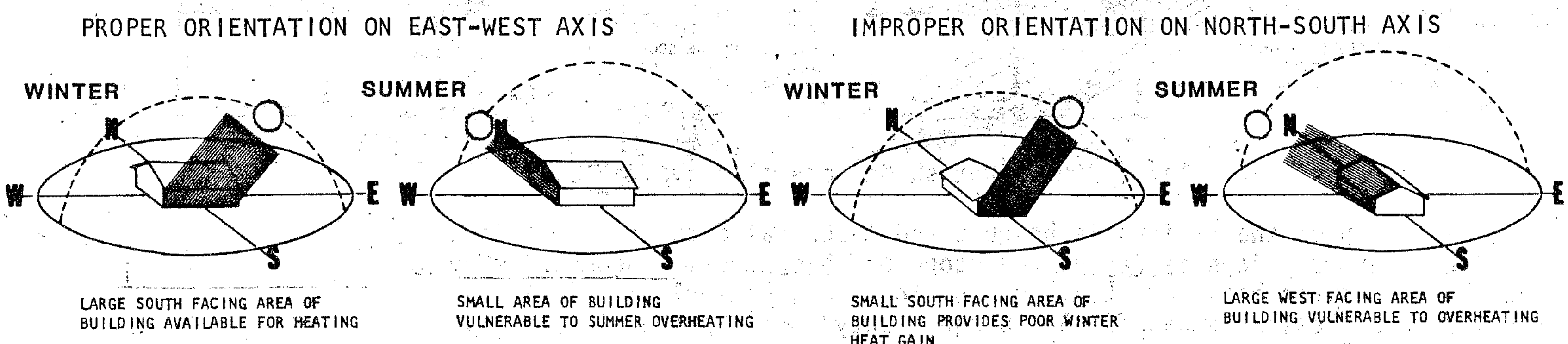
GUIDELINES

A. Lot and Building Orientation

- In order to preserve passive solar opportunities, Subdivisions and Planned Residential Developments featuring individual lots should be designed to accommodate appropriate lot-building relationships. Two major factors need to be taken into consideration:

    1. The lots must be designed and oriented to accommodate buildings which have an appropriate ratio of south facing glazing to total building floor area. The exact ratio can be obtained from the State Title 24 Energy Guidelines depending on which alternative is selected. As a general rule this means that the long axis of the building should be sited in an east- west direction. An east-west siting will allow one of the long walls to face south.

(FIGURE 2)
BUILDING ORIENTATION



As can be seen from the above illustration, locating the long axis of the building in an east-west direction provides for a more even heat distribution as the sun moves across the southern sky. An improper orientation does not allow proper solar heating in winter and adds to summer air conditioning costs. An additional advantage of an east-west orientation is that it permits active solar systems to be easily integrated into the structure as well, since ample south-facing roof surfaces should be available.

The concept of a building orientation utilizing an east-west axis represents a general principle which may be successfully challenged through the use of more complex architectural forms. The point to remember, however, is that all passive solar buildings (including those which have no discernable axis) must still provide for adequate south-facing collector surfaces.

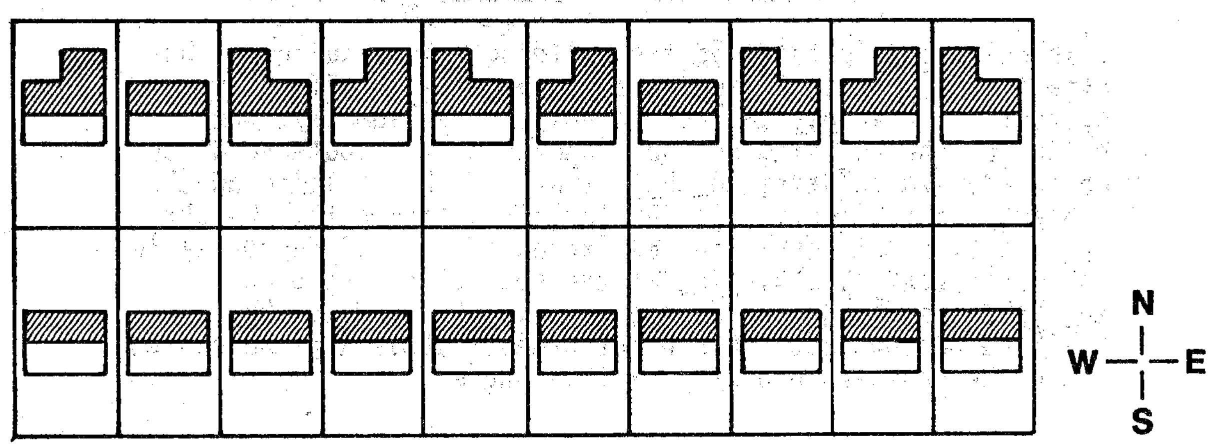
2. The lots must be designed and oriented to permit unencumbered solar access to each of the buildings south walls taking into account proposed building heights and setbacks on each successive lot.

For example:

o If the lots run north-south then the building axis should generally run perpendicular to the lot.

(FIGURE 3)

NORTH-SOUTH LOTS WITH EAST-WEST BUILDINGS

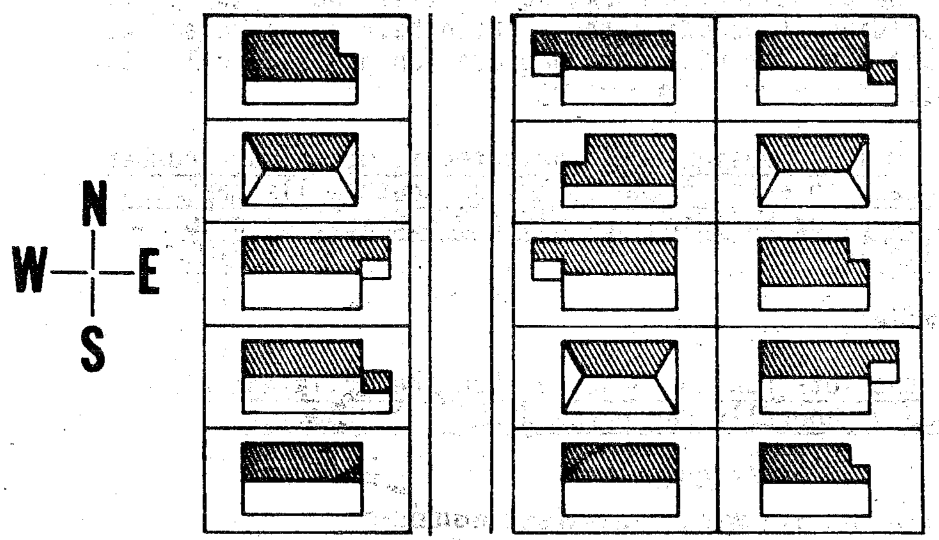


This pattern easily fulfills requirements 1 and 2. since each building is afforded a large south wall surface and the ample rear yard setbacks guarantees protection from the shadows of neighboring structures.

o <u>If the lot runs east-west then the buildings should generally run parallel to the lot.</u>

(FIGURE 4)

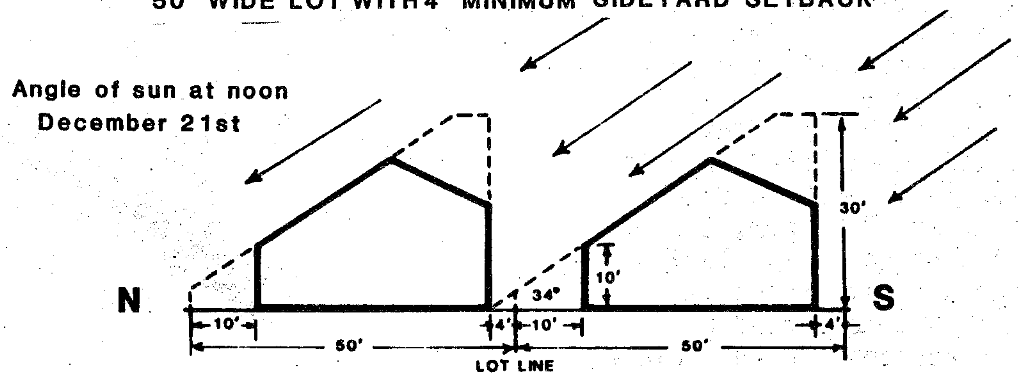
EAST-WEST LOTS WITH EAST-WEST BUILDINGS



This relationship fulfills the building axis requirement but establishes a more difficult design problem in efforts to protect solar access to the south wall. In summary, the height of the building on the property to the south needs to be controlled relative to the setback of the building on the property to the north. At San Diego's latitude this height to setback relationship can be expressed by a 34-degree angle (from horizontal) beginning at the setback of the property to the north, sloping towards the south. The roof of the building to the south should not project above a plane canted above the southern property at this angle.

(FIGURE 5)

BULK PLANE SOLAR ENVELOPE - FOR TYPICAL
50' WIDE LOT WITH 4' MINIMUM SIDEYARD SETBACK

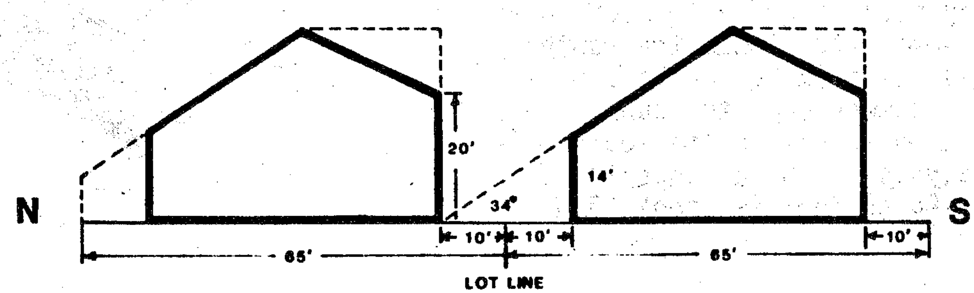


The 34-degree angle represents the angle of the sun at 12 noon on December 21 when the sun is in its lowest yearly path relative to the horizon. Coincidentally, this angle is nearly identical to a 1.5:1 slope which makes a field check of the building envelope relatively easy.

o The design impact of the 34-degree slope on the building envelope to the south can be reduced, if necessary, by <u>increasing the width</u> of the lots and the side yard setbacks.

(FIGURE 6)

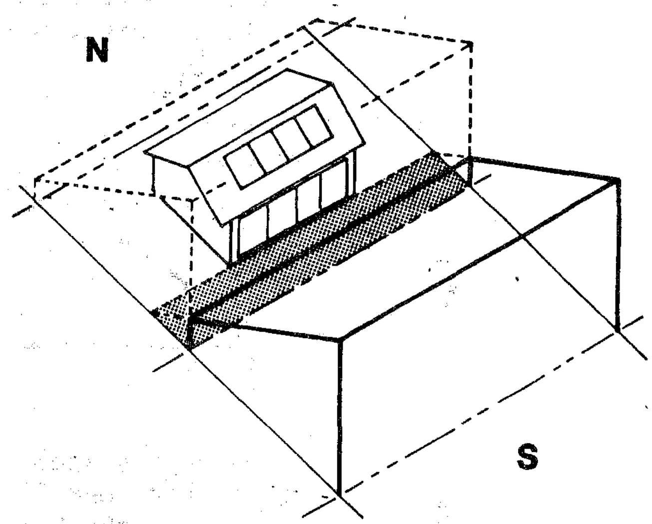
BULK PLANE SOLAR ENVELOPE - FOR
65' WIDE LOT WITH 10' SIDEYARD SETBACK



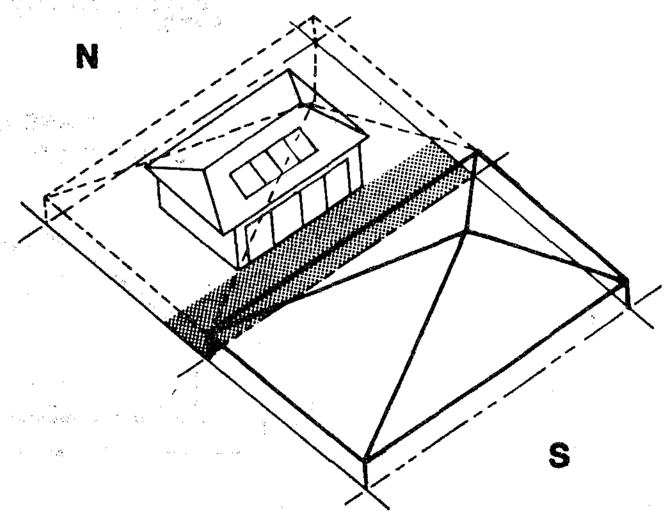
This type of solar access protection envelope is typically referred to as a bulk plane. It is important to recognize that the bulk plane, while based on solar angles, represents a compromise. On December 21, the bulk plane still allows some shading in the morning and afternoon hours. This is because at any time other than noon the sun will be even lower than 34 degrees. Between 9:00 a.m. and 3:00 p.m, the most productive period of solar insolation, the angle of the sun will reach its yearly low for this time period of 19 degrees from the horizon. A bulk plane set at 19 degrees from horizontal would provide perfect solar access during the 9:00 a.m. - 3:00 p.m. December 21 time period. However, the benefits to be gained by the solar collector owner are outweighed by the severe loss of buildable area which would result to the adjacent property to the south.

One alternative which has considerable merit, is the use of a full solar envelope adjusted for both seasonal and daily solar angles. The full solar envelope incorporates the basic features of the bulk plane but the east and west sides are sloped to accommodate variations in morning and afternoon solar angles. In some situations, the south side is angled steeply to handle a brief period in the summer when the sun actually casts a shadow to the south. (A thorough analysis of these concepts is contained in Ralph Knowles' book "Sun Rhythm Form".)

(FIGURE 7) **BULK PLANE ENVELOPE**

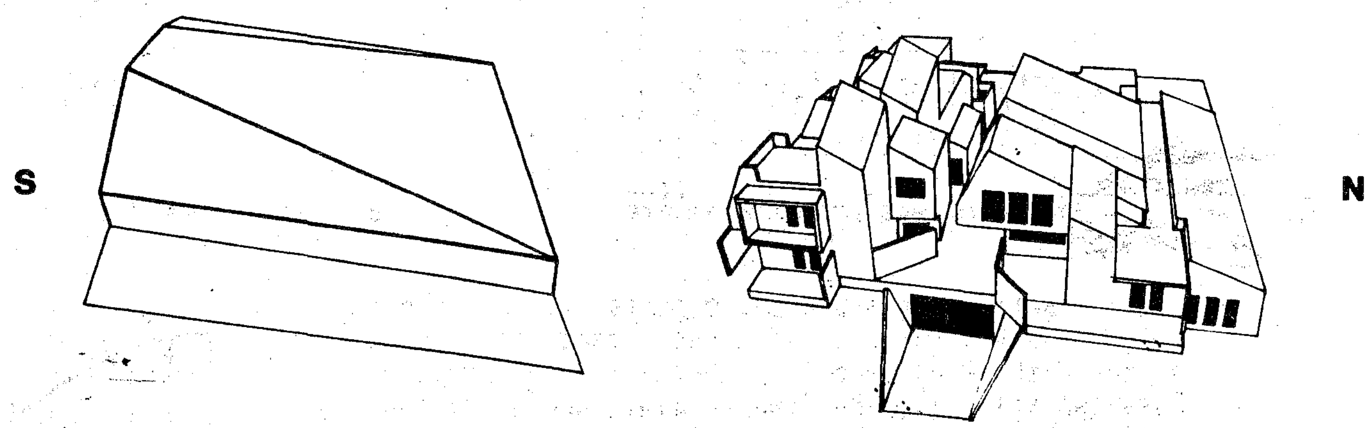


FULL SOLAR ENVELOPE



While this technique may not be practical for the typical subdivision, developers are strongly encouraged to consider full solar envelope concepts for cluster developments within medium to high density Planned Residential Developments. The building shapes which result can be very attractive as well as functional.

(FIGURE 7)

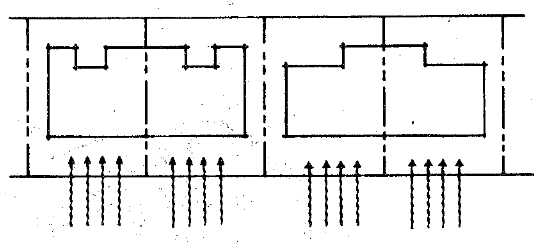


Zero lot line and townhouse units have unique solar orientation requirements. As in single-family units, passive solar applications require that each unit have an adequate area of south facing glazing. If the development features attached units on individual lots however, the options for proper building orientation are limited.

(FIGURE 8)

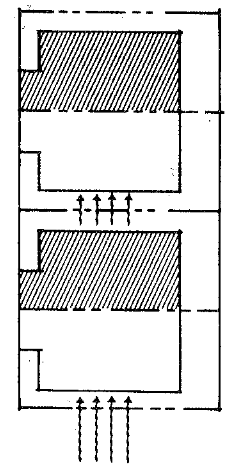
ZERO LOT LINE ORIENTATIONS

GOOD



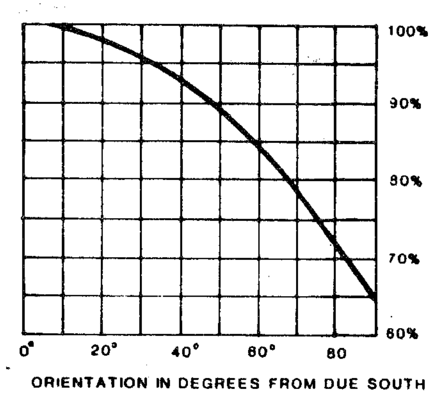
BOTH UNITS HAVE GOOD SOUTH EXPOSURE

POOR



ONLY ONE UNIT HAS GOOD SOUTH EXPOSURE

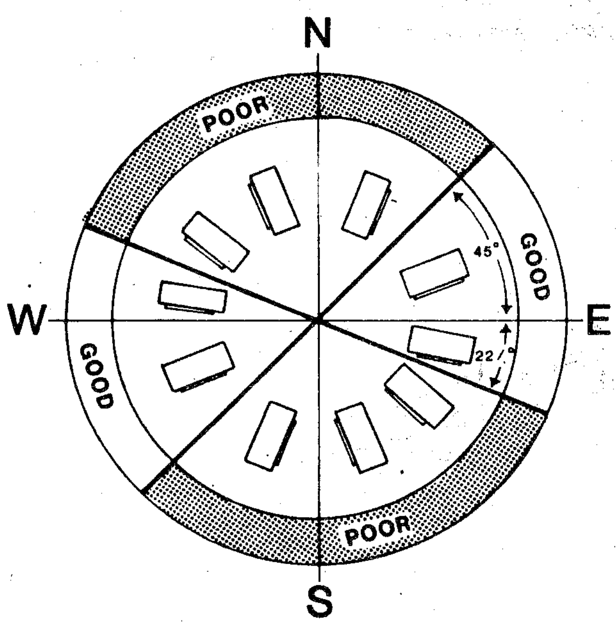
o Often due to topographic constraints and the need to align subdivisions with adjacent street patterns, a true north-south or east-west lot pattern is not feasible. For most solar applications in San Diego's latitude the collectors may be oriented up to 45 degrees from true south. This orientation will preserve approximately 90 percent of the efficiency of a flat plate solar collector. Passive solar heating systems, however, incur significant overheating libilities when windows (collectors) are oriented more than 22 1/2 degrees to the west of true south.

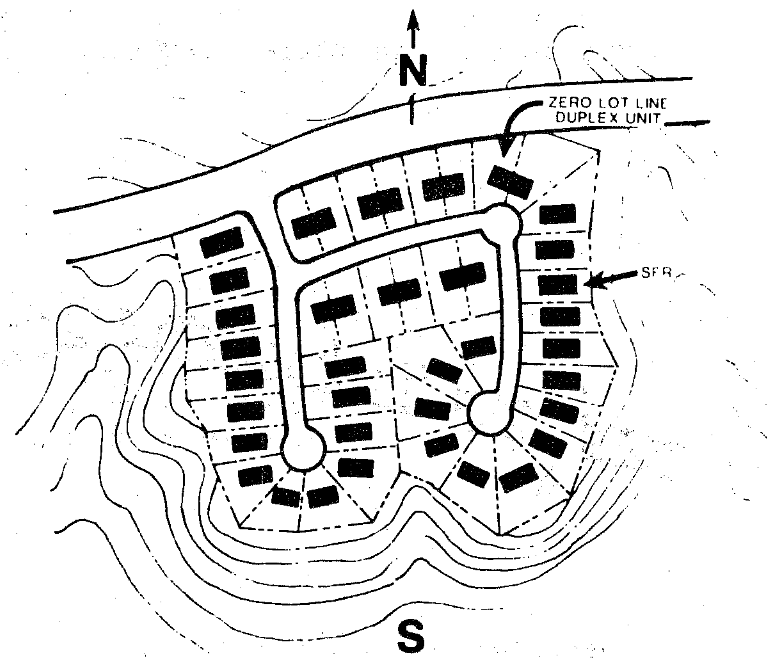


EFFECT OF SOLAR COLLECTOR ORIENTATION ON ANNUAL HEATING PERFORMANCE

(FIGURE 9)

VARIABILITY OF COLLECTOR ORIENTATION





LONG AXIS ORIENTATION FOR DETACHED HOMES

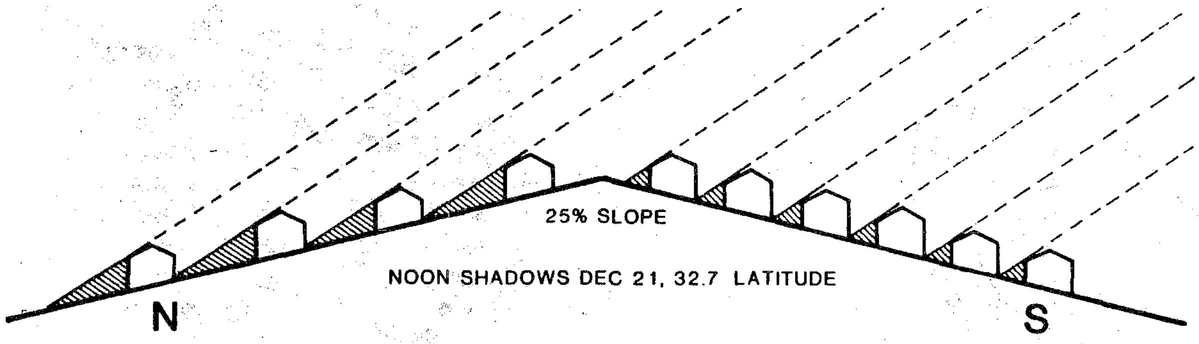
POSSIBLE SUBDIVISION ORIENTATION
(NOTE: FLEXIBLE EAST-WEST ORIENTATION
OF ALL UNITS)

B. Slopes

- North slopes increase shadow lengths and therefore require even greater setbacks to retain solar access. In general north slopes should either not be developed or reserved for very low densities.

(FIGURE 10)

EFFECT OF NORTH AND SOUTH FACING SLOPES ON SHADOW LENGTH AND DENSITY



- South slopes decrease shadow lengths and therefore are ideal for high density clustering.

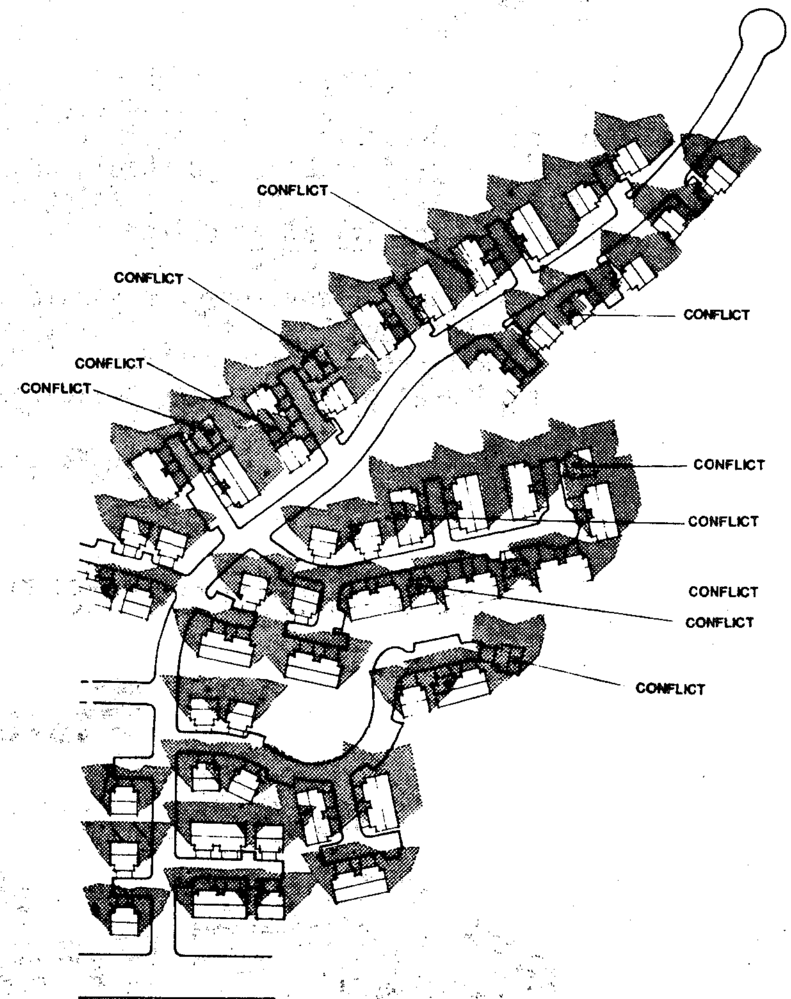
  All developments, however, must comply with the City of San Diego's Hillside protection policies. Hillside review guidelines preserving erodable or steep slopes must take priority over solar objectives. For this reason, topographic, environmental, or other physical constraints may have a determining influence on lot orientation.

C. <u>Shadow Analysis</u>

Assuming that a building is properly oriented, the greatest threat to the use of solar energy is shading. The most effective way to demonstrate the opportunity for passive solar energy use is to provide a ground level shadow plan as an overlay to the subdivision map or PRD site plan. The shadow plan must detail the assumptions used regarding building heights and setbacks.

(FIGURE 11)

SHADOW PLAN



GROUND LEVEL SHADOWS BETWEEN 9:00 AM AND 3:00 PM, DEC 21

Whenever a shadow is cast into the foot print area (inside the setback) of another building, solar access to the south wall may be impeded. Such conflicts can be eliminated by reducing building heights, altering roof lines, increasing setbacks, or redesigning the lots.

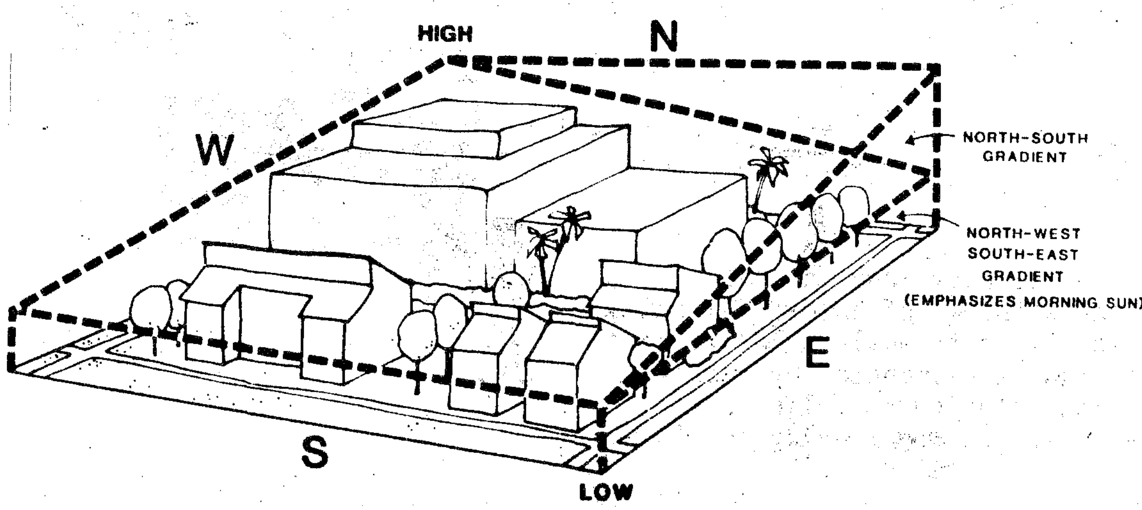
A simple method to determine shadow lengths is contained in Appendix A. In evaluating shading effects, shadows shall be based on a composite of the lengths which would be observed on December 21, between 9:00 a.m. and 3:00 p.m.

In planned residential developments containing clustered units and/or high rise structures, passive solar designs requiring south wall access may not be feasible. The protection of rooftop access however, is almost always feasible, and should be provided. Additionally, care should be taken to avoid the shading of recreational use areas unless shading is specifically desired.

- Mixed height developments should be sited in a general north to south or northwest to southeast gradient with the highest structures on the north side. This will provide maximum solar exposure for each of the buildings.

(FIGURE 12)

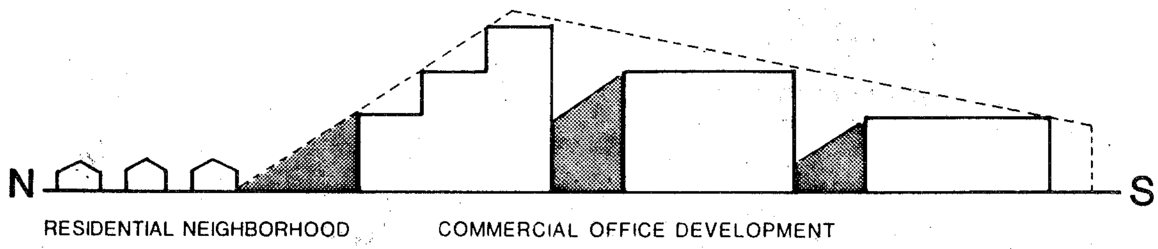
HEIGHT GRADIENT FOR LARGE PLANNED DEVELOPMENTS



A bulk plane adjustment, however, may be required to protect solar access for neighboring property to the north.

(FIGURE 13)

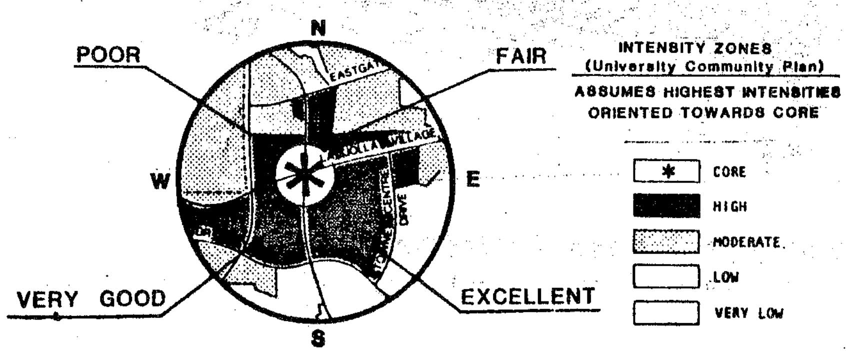
MODIFIED HEIGHT GRADIENT



o Existing land use and urban design considerations may require project intensities to be oriented in ways which are not optimal for solar access. An example would be a mixed use project which requires high intensity commercial uses to be oriented toward core area activity centers defined in a community plan.

(FIGURE 14)

LAND USE INTENSITY-SOLAR ACCESS COMPATIBILITY
(FOUR KEY PLANNED DEVELOPMENT SITES)

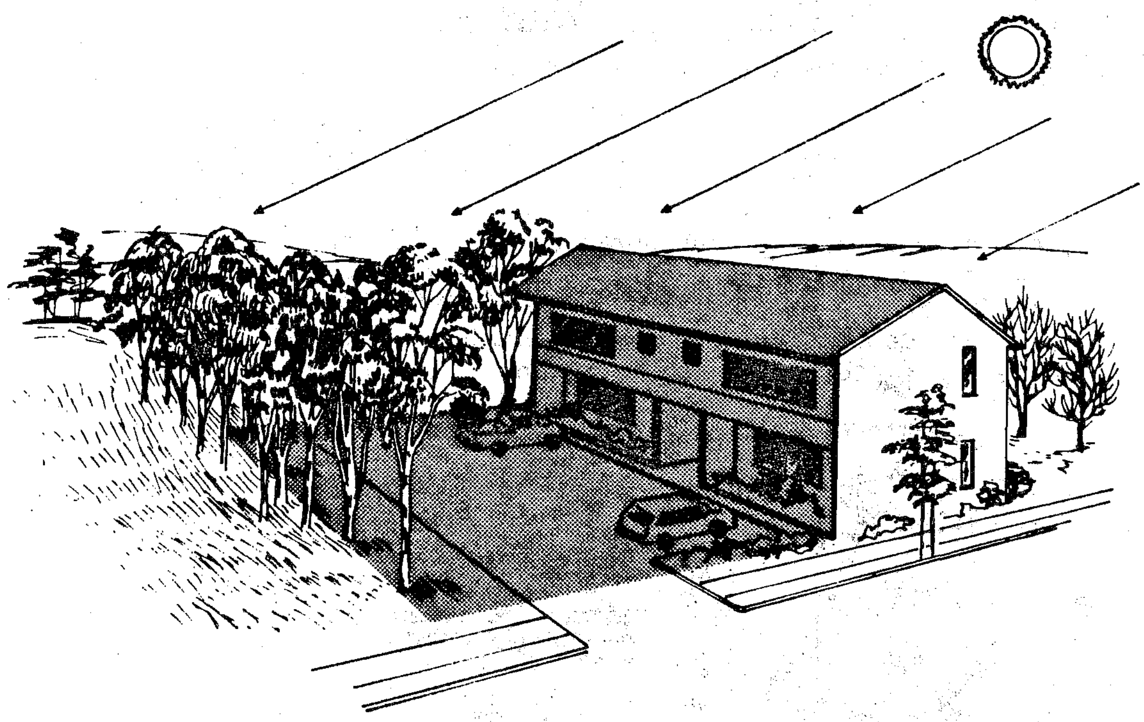


Such situations present a more challenging design problem which may be addressed through the use of properly angled roofs and increased open space between buildings.

o Whenever possible, locate parking areas and other utilitarian uses in the shadow impacted areas on the north sides of buildings.

(FIGURE 15)

NORTH PARKING LOT



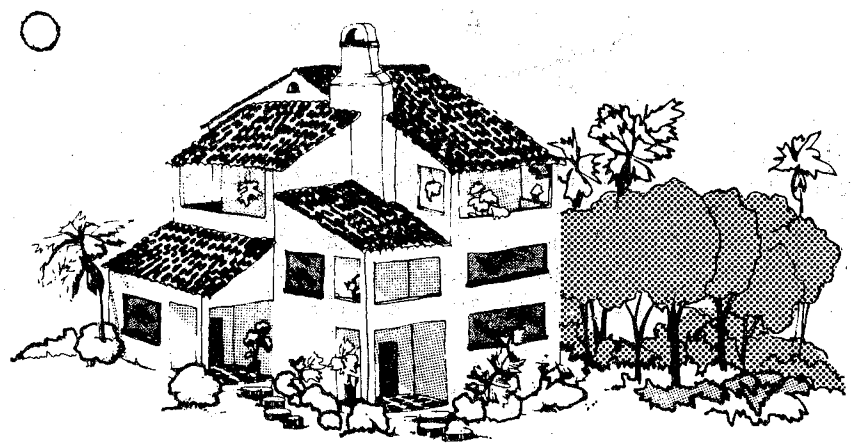
Parking areas may also be used as a shadow buffer area between buildings.

D. Open Space

- The required open space in Planned Residential Developments should be utilized in a manner which is sensitive to the solar access needs of a development. Since open space has many potential uses, the needs and priorities of each individual site will vary. Aside from safety considerations, which must take priority, the objective is to obtain a realistic balance between solar access, recreation, aesthetic, and privacy considerations. Open space, for example, may be used to buffer buildings from undesirable shadows and to protect solar access. Such open space, however, may not be suitable for many types of recreational uses. In summary, the open space provided should be utilized to meet specific objectives rather than to demonstrate compliance with minimum standards.

- Existing wooded areas which already provide ample amounts of shade are ideal for use as open space buffers. The impact of building shadows into such areas is minimized because their shaded quality has already been established. Wooded areas may have a potential recreational use as well.

(FIGURE 16)

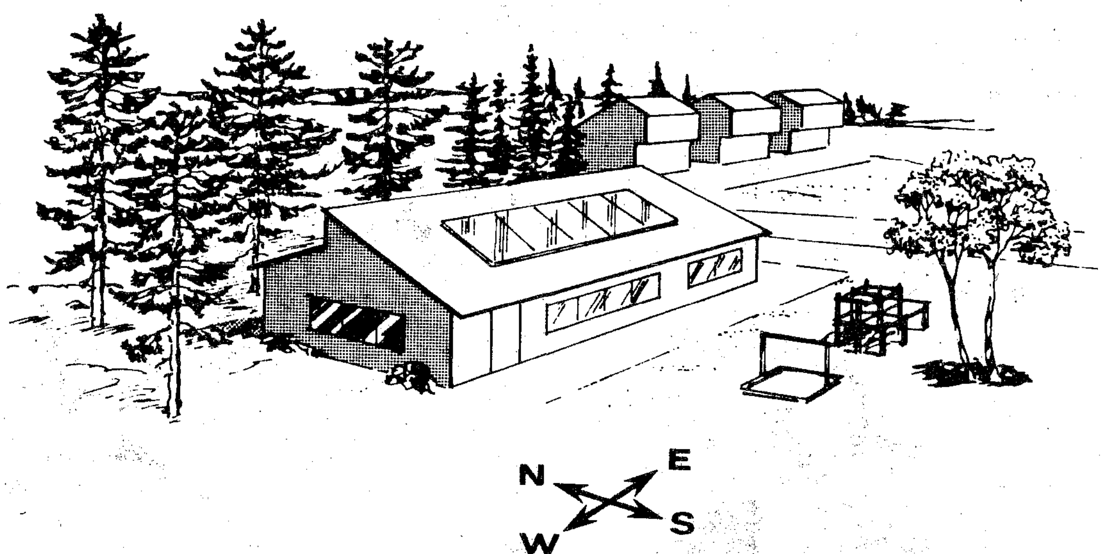


E. Vegetation

- Existing trees and natural vegetation should be evaluated for their usefulness in providing desired shade and incorporated into overall project design. However, to maintain adequate sunlight, buildings and recreational areas should be located south of any large evergreen trees.

(FIGURE 17)

LOCATION OF BUILDINGS SOUTH OF EVERGREEN TREES



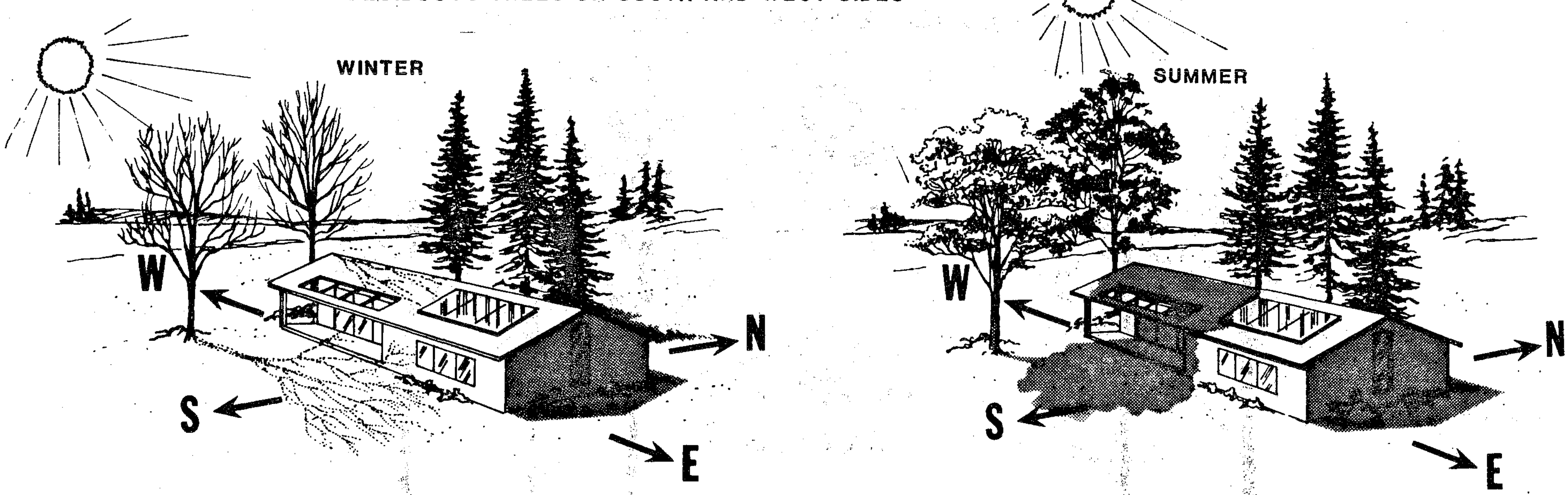
The existing natural vegetation provides a valuable temperature moderating resource for passive solar designs. Although introduced landscaping will provide many of the same benefits, established vegetation has a number of advantages in maturity, slope stability, and proven adaptability to the site.

- Trees and shrubs should be sited to maintain unencumbered access to all solar collectors. Even partial shading of a collector can result in a substantial reduction in capacity. If 10 percent of a collector surface is shaded, the system can lose as much as 20 percent of its capacity.

- Passive solar applications, such as space heating and cooling rely on the effective <u>management</u> of sunlight and shade. Deciduous trees, which drop their leaves during the winter and leaf-out during the summer months are ideal for this purpose. Such trees located on the south and west side of a structure allow substantial amounts of sunlight for solar space heating in the winter and shade for cooling in the summer.

(FIGURE 18)

DECIDUOUS TREES ON SOUTH AND WEST SIDES



BARE BRANCHES PERMITS SUNLIGHT TO PENETRATE SOUTH FACING WINDOWS

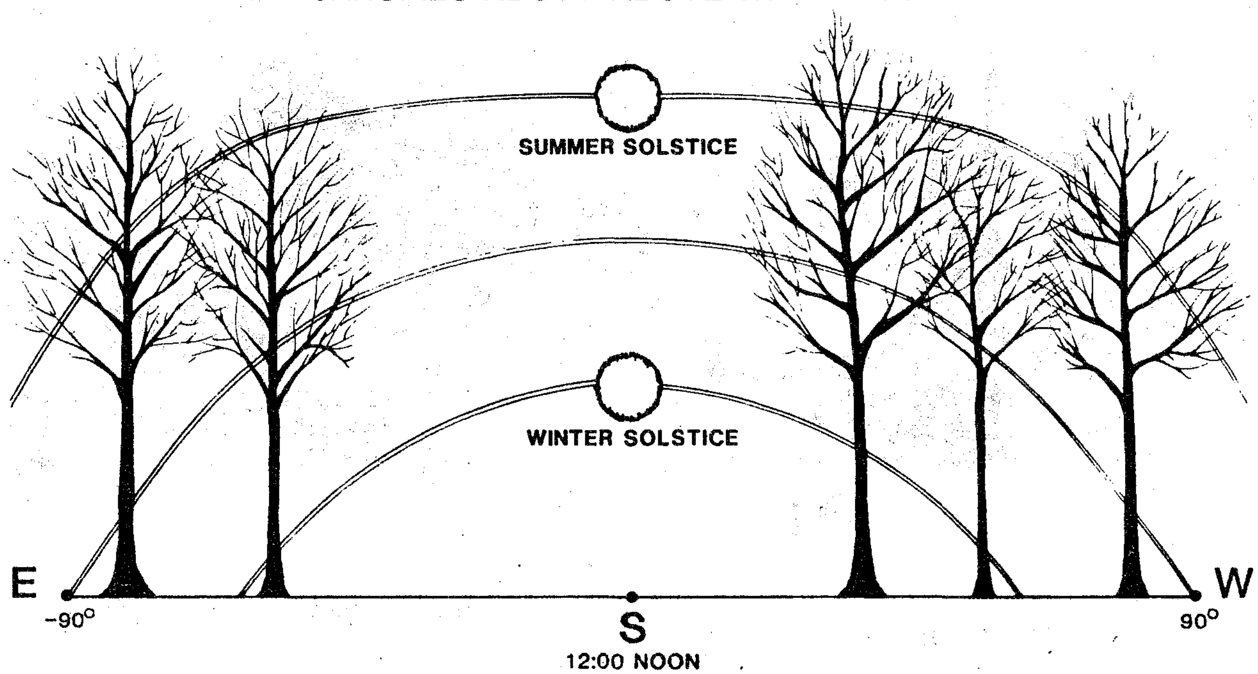
FOLIAGE PROVIDES SHADE FOR COOLING

Species should be selected to coincide with the seasonal heating and cooling requirements of the site. In San Diego's mild climate, many deciduous trees retain their leaves well into December and leaf out again in March. It is also important to consider the heights of the trees at maturity, extent of crown, and bare twig and branch densities. Bare twig patterns can reduce sunlight anywhere from 20 percent to 80 percent. Sunlight penetration, however, can be improved by judicious pruning.

o To maximize solar access in winter and shading in summer, deciduous trees should be planted so that the bare branch canopy will be well above the sunpath during the winter solstice.

(Figure 19)

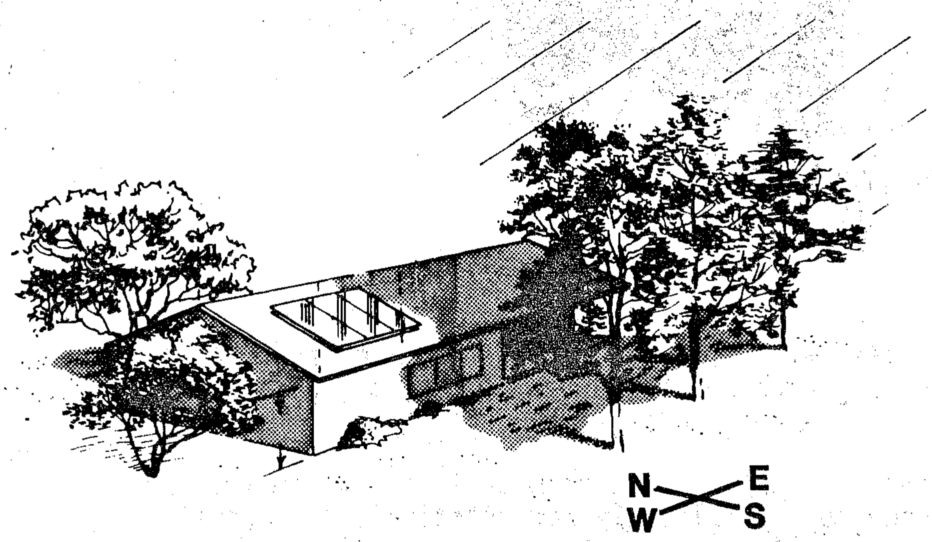
TREE CANOPIES ABOVE ABOVE WINTER SUN PATH



o A potential conflict exists between the shading requirements for passive heating and cooling and the need for direct solar access for hot water and photovoltaic collectors. The solution lies in the careful consideration of both tree location and the relative priorities given to the various solar applications. Solar hot water heating, for example, requires about 100 square feet of roof collector area per unit. Photovoltaics may require up to 200 square feet. By setting aside, and maintaining a minimum unshaded roof area for the solar collectors proposed for the project, the remaining roof area is available for shading as needed. Additionally, roof collectors may be strategically located to retain maximum shading opportunities.

(FIGURE 20)

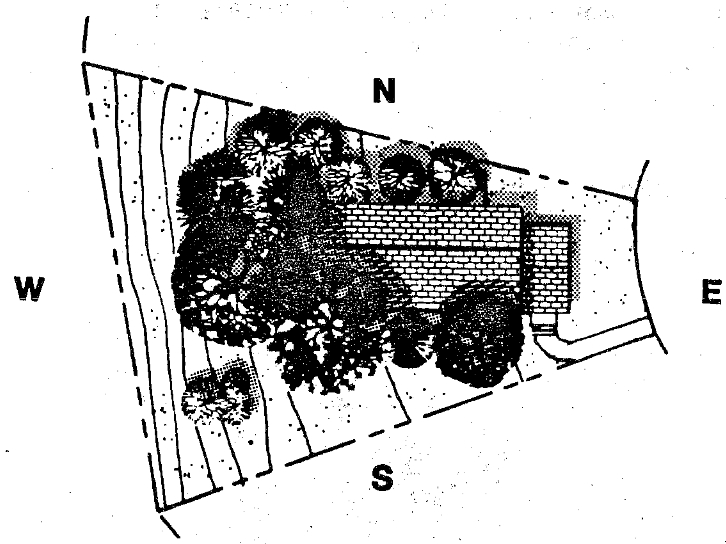
MINIMUM UNSHADED ROOF AREA



On most sites trees should be located to provide late afternoon shade on the west and southwest building exposures. Heat buildup is greatest along western exposures especially west facing slopes. Microclimatic conditions however may influence desired tree placement.

(FIGURE 21)

TREE PLACEMENT ON WEST AND SOUTHWEST EXPOSURES



F. <u>Microclimate</u>

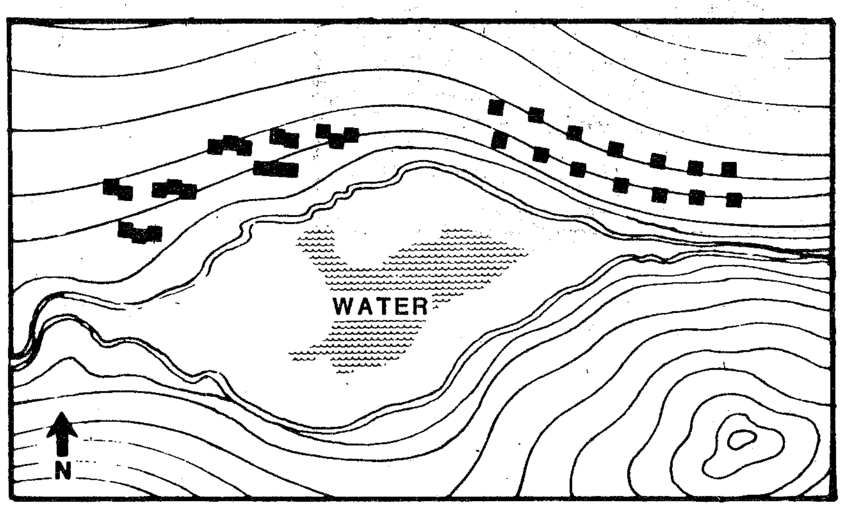
Buildings should be sited with respect to the natural microclimatic features of the site. Extreme conditions of heating or cooling should be avoided.

An optimal development orientation with respect to microclimatic and topographic factors may be possible only for relatively low density developments on very large sites. The objective to utilize natural conditions to moderate energy needs however, remains the same for all developments. An effective way to approach the complex interplay of development siting factors is to prepare a composite site plan showing all of the natural constraints and opportunities (see Appendix B). It is recommended that such plans be submitted during the environmental review process and made available during hearings before the Planning Director and Subdivision Review Board.

o Building sites should be located as close as possible to natural bodies of water. Water, with a higher specific heat than land, is normally warmer in winter and cooler in summer, and usually cooler during the day and warmer at night than land. Proximity to bodies of water moderates extreme temperature variations on adjacent land. Development, however, should not be sited within sensitive habitat areas around lakes, and coastal lagoons nor in areas subject to periodic flooding. Where a potential conflict exists the requirements of the City's Sensitive Coastal Resource Zone and Flood Plain Fringe Zone shall have priority.

(FIGURE 22)

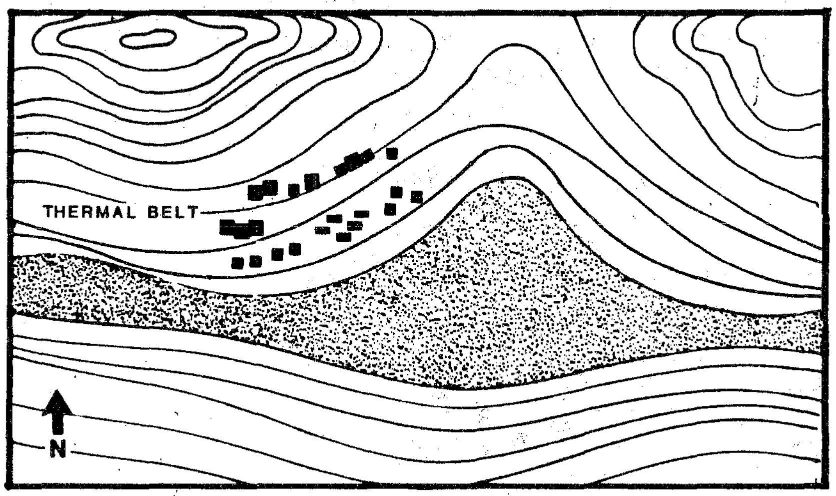
BUILDING SITES NEAR NATURAL BODIES OF WATER



o Sites should be selected where fog will not be retained for long periods of time during the diurnal cycle such as in certain coastal areas and east-west canyons. Fog pockets are often indicative of excessively cold areas with poor air movement and inadequate levels of solar radiation. In general, fog will linger less at higher elevations which have good air circulation.

(FIGURE 23)

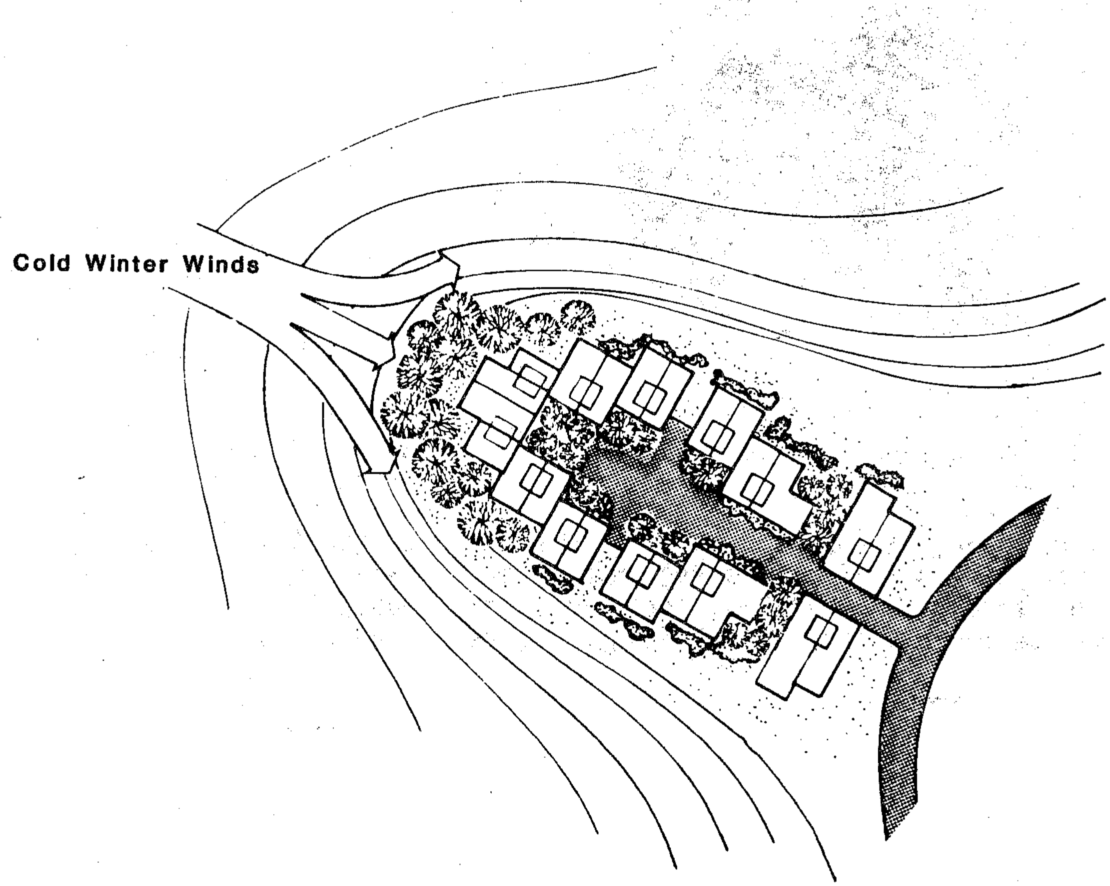
AVOIDANCE OF FOG PRONE AREAS



- Attached units should be clustered with respect to one another so that major terraces and outdoor living areas are oriented toward the interior of the building clusters. The clustering of structures can reduce wind effects by channeling air movements around a development, thus improving heat absorption within the cluster. Additionally, the reduction of surface area through the use of common walls, helps to minimize temperature losses as well as losses due to wind infiltration. The clustering however need not be rigid; flexibility in building design is still possible.

(FIGURE 24)

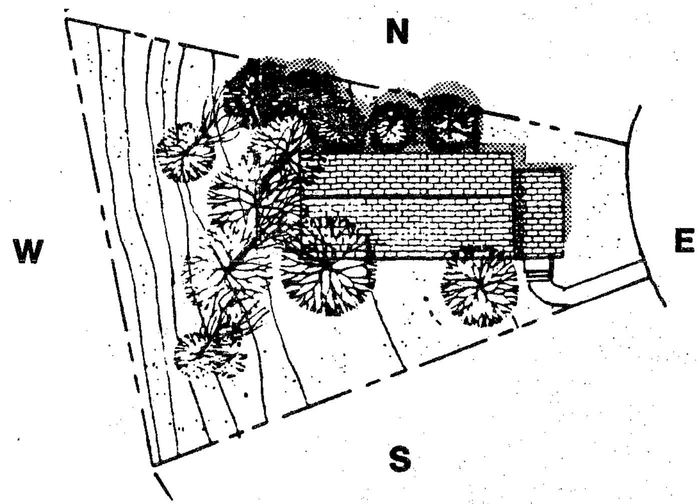
CLUSTERING DEVELOPMENTS TO REDUCE WIND EFFECTS



o Where necessary, evergreen trees should be planted in groupings to provide protection against cold winter winds. The variation in the direction of summer and winter winds often allows wind breaks to be sited close to a building without significant interference to summer breezes or solar access.

(FIGURE 25)

PLACEMENT OF EVERGREEN TREES ON NORTHWEST SIDE OF HOUSE

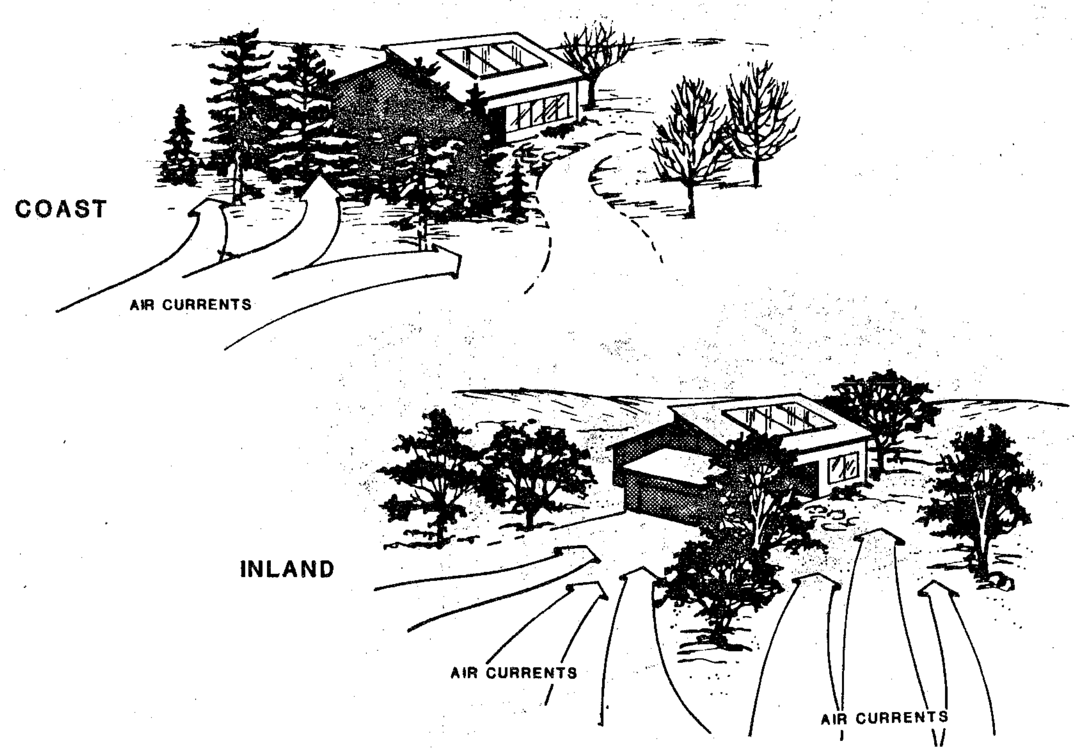


o Local topography has a major influence on wind patterns. For this reason, few regional generalizations regarding seasonal wind direction can be made. If available, local wind data should be considered, before designating tree plantings. (See Appendix C.)

o Persistent onshore coastal breezes may result in excessive winter-time cooling unless properly attenuated. On west-facing shoreline areas, evergreen windbreaks are appropriate provided they do not block access to solar collectors.

(FIGURE 26)

TREES USED TO CONTROL BREEZES



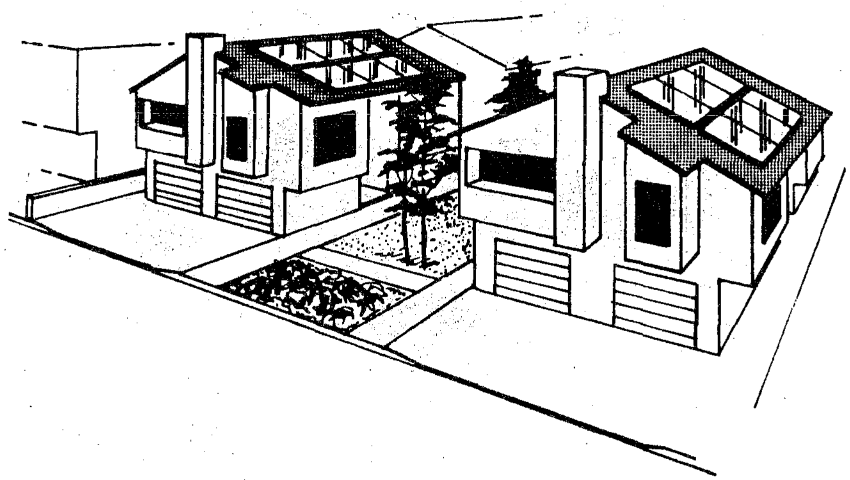
o On inland sites, having warmer summers, vegetation can be planted to funnel cooling breezes. Roads and driveways can also be oriented to avoid winter winds and to channel summer breezes.

G. Collector Design

Whenever possible, solar collectors should be integrated into the architectural theme of the building. Solar collectors, like television aerials, vents, and air conditioning equipment have the potential to degrade the aesthetic quality of a building. Ideally, south facing roof surfaces supporting flat collectors should be optimally pitched to obtain maximum year round solar insolation and still allow for flush mounting. Where design flexibility permits, solar collectors should be made as unobtrusive as possible.

(FIGURE 27)

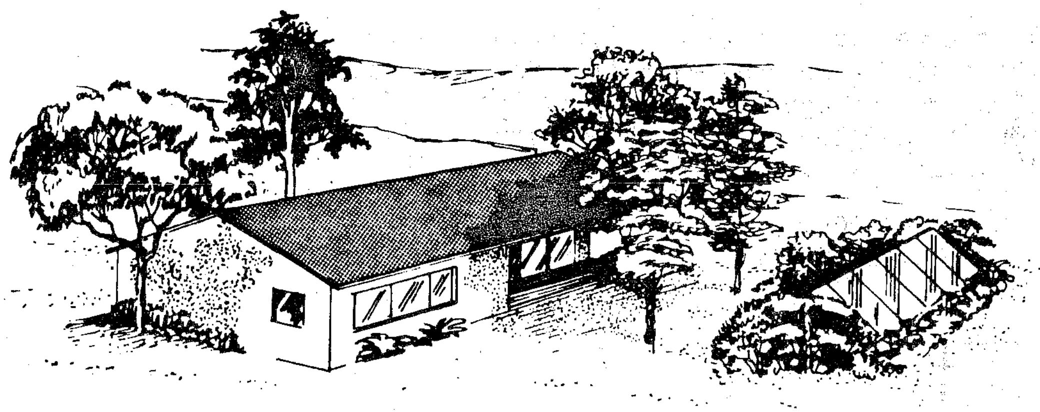
SOLAR COLLECTORS INTEGRATED WITH DESIGN



o Detached collectors should be screened from view entirely, if feasible.

(FIGURE 28)

DETACHED COLLECTORS



APPENDIX A

DEVELOPING A SHADOW PLAN

This section describes a simple method to develop a ground shadow plan similar to that illustrated on page 13 of this guidebook.

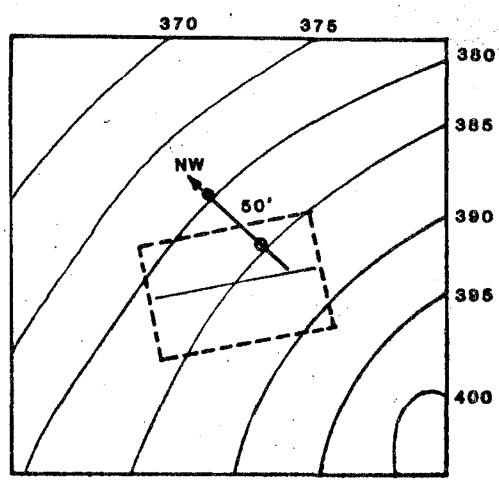
Step 1

Determine the approximate percentage of slope and the slope direction in the vicinity of each building on the site plan.

Example:

The percentage slope equals the vertical distance divided by the horizontal distance. In this case, the distance between each five-foot vertical contour is 50 feet. The slope percentage therefore will be five feet divided by 50 feet which equals ten percent. The direction of the slope is designated to be northwest since this is the general direction that the slope descends.

(FIGURE 1)



$$\text{SLOPE} = \frac{\text{VERTICAL DISTANCE}}{\text{HORIZONTAL DISTANCE}} = \frac{385' - 380'}{50'} = \frac{5'}{50'} = 10\%$$

Step 2

From the Shadow Length Multiplier table below, find the shadow lengths of a one foot pole at 9:00 a.m., noon, and 3:00 p.m. These will be the values at the intersection of NW and ten percent.

(FIGURE 1A)

	N			NE			E			SE			S			SW			W			NW		
SLOPE	AM	NOON	PM	AM	NOON	PM	AM	NOON	PM	AM	NOON	PM	AM	NOON	PM	AM	NOON	PM	AM	NOON	PM	AM	NOON	PM
0% -	3.1	1.5	3.1	3.1	1.5	3.1	3.1	1.5	3.1	3.1	1.5	3.1	3.1	1.5	3.1	3.1	1.5	3.1	3.1	1.5	3.1	3.1	1.5	3.1
5% -	3.4	1.6	3.4	3.1	1.6	3.6	2.8	1.5	3.4	2.7	1.4	3.1	2.8	1.4	2.8	3.1	1.4	2.7	3.4	1.5	2.8	3.6	1.6	3.1
10% -	3.9	1.7	3.9	3.1	1.7	4.4	2.5	1.5	3.9	2.3	1.3	3.1	2.5	1.3	2.5	3.1	1.3	2.3	3.9	1.5	2.5	4.4	1.7	3.1
15% -	4.5	1.9	4.5	3.1	1.8	5.7	2.3	1.5	4.5	2.1	1.3	3.1	2.3	1.2	2.3	3.1	1.3	2.1	4.5	1.5	2.3	5.7	1.8	3.1
20% -	5.4	2.1	5.4	3.1	1.9	7.9	2.1	1.5	5.4	1.9	1.2	3.1	2.1	1.1	2.1	3.1	1.2	1.9	5.4	1.5	2.1	7.9	1.9	3.1

Note: This Table gives the shadow length on December 21 of a one-foot pole for different slopes and directions.

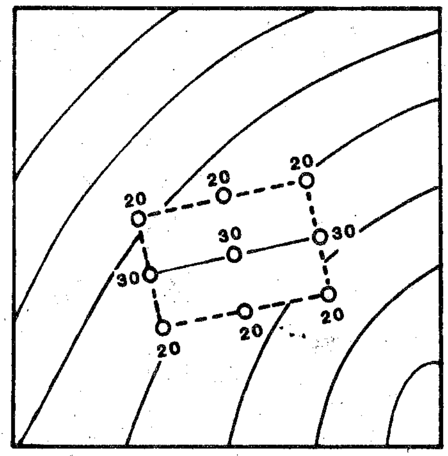
From Table:

9:00 a.m.	Noon	3:00 p.m.
4.4 feet	1.7 feet	3.1 feet

Step 3

Abstract each building on the site plan into a set of poles. The poles will normally be positioned at each corner of the building, at the center point of each roof edge and along the ridge line of the roof. Assign each pole a height corresponding to the roof height at that point.

(FIGURE 2)



Step 4

Multiply the values for a one foot pole by the actual height of each pole to obtain the true shadow length.

9 a.m. value		pole height		9 a.m. shadow length
4.4 feet	x	30 feet	=	132 feet
	x	20 feet	=	88 feet
Noon value				**Noon length**
1.7 feet	x	30 feet	=	51 feet
	x	20 feet	=	34 feet
3 p.m. value				**3 p.m. length**
3.1 feet	x	30 feet	=	93 feet
	x	20 feet	=	62 feet

Step 5

Scale the three shadow lengths out on paper for each pole. The 9:00 a.m. shadow will project toward the northwest at 45 degrees from true north; the noon shadow will project true north, and the 3:00 p.m. shadow will project northeast at 45 degrees from true north. The figure below shows a complete shadow pattern for a single pole.

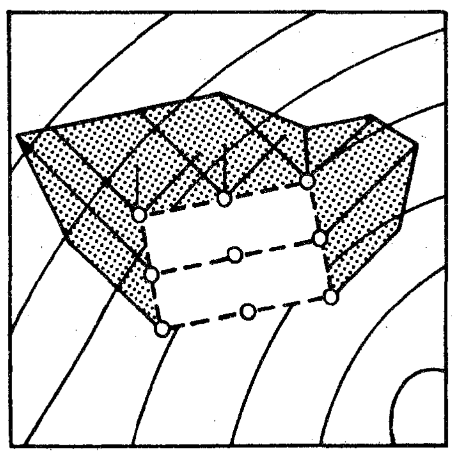
(FIGURE 3)

30' POLE

APPROXIMATE SHADOW PATTERN FOR ONE 30' POLE ON 10% NW SLOPE

When plotted for each pole height, a shadow pattern for the entire building begins to emerge. The shadow plan is completed when each line is connected and the interior area is shaded in.

(FIGURE 4)



This process can be simplified by using templates for standard heights and slopes found throughout the project.

The calculations required for shadow plan analysis are ideally suited for computers equipped with graphic plotters. An existing program called "Perspective" has the capability to perform this kind of analysis and is now available for use with the IBM PC and compatible computers. It is anticipated, that other inexpensive programs will soon be available to handle almost any kind of shadow analysis problem. Architects and site planners are encouraged to utilize these systems.

APPENDIX B

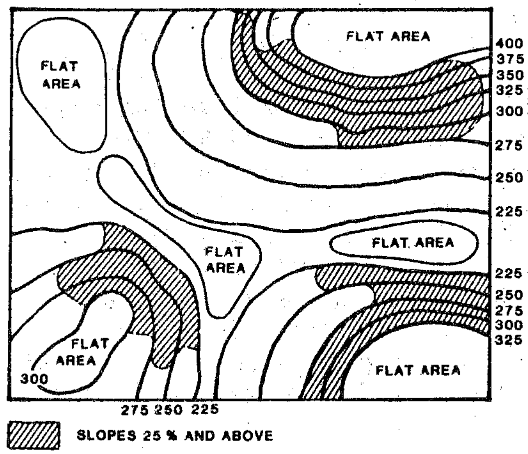
PRELIMINARY SITE ANALYSIS

The Planning Department recognizes that development site plans must be sensitive to many different environmental factors in addition to solar access considerations. In some instances, the generalized siting principles appropriate for one environmental concern may conflict with the principles designed to address another concern. A good site plan however seeks to minimize such conflicts. This section outlines a logical procedure to identify the development opportunities and constraints available to a given site. Such a procedure provides a useful framework to analyze and support development decisions that may have significant environmental consequences. Whether these exact procedures are used or not, developers are encouraged to explain key environmental decisions behind a specific site plan proposal.

Procedure 1. <u>Map physical characteristics of the site.</u>

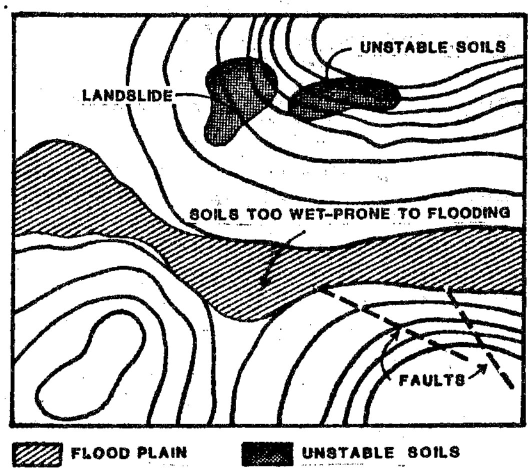
- Indicate original topographic contours and mark site elevations.
- Map areas with 25 percent slope and above. Indicate flat areas.

(FIGURE A)



o Indicate any areas with geologic hazards or soil stability problems.

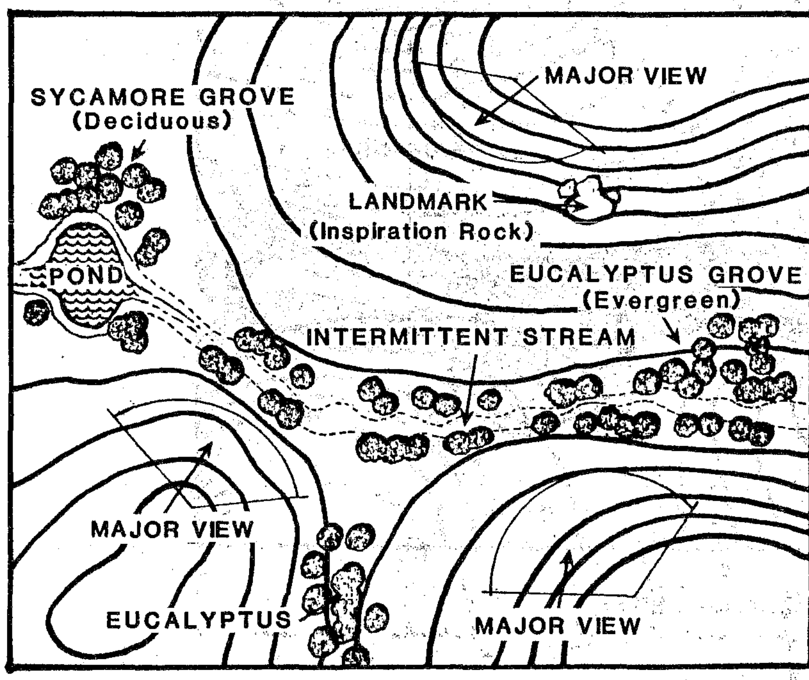
(FIGURE B)



- Map major stands of trees and other significant vegetation. Note dominant species type, height, whether deciduous or evergreen, and shade impacted areas.

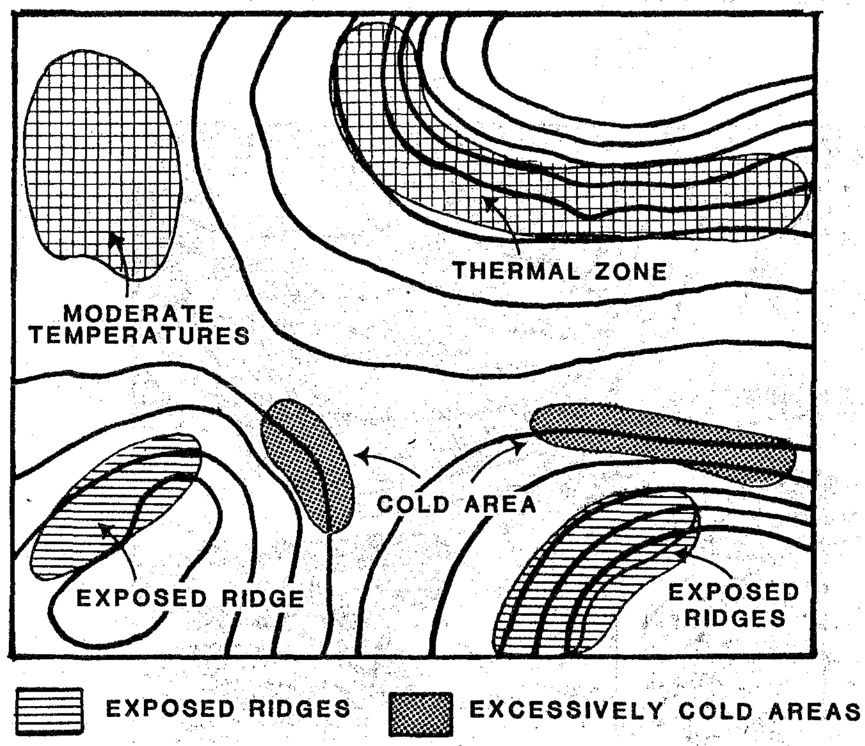
- Mark all significant natural features such as water courses, ponds, rock outcropping, or scenic viewshed areas.

(FIGURE C)



- Mark potential frost or fog pockets indicating unusually cold areas.
- Indicate exposed ridges and thermal belt areas.

(FIGURE F)

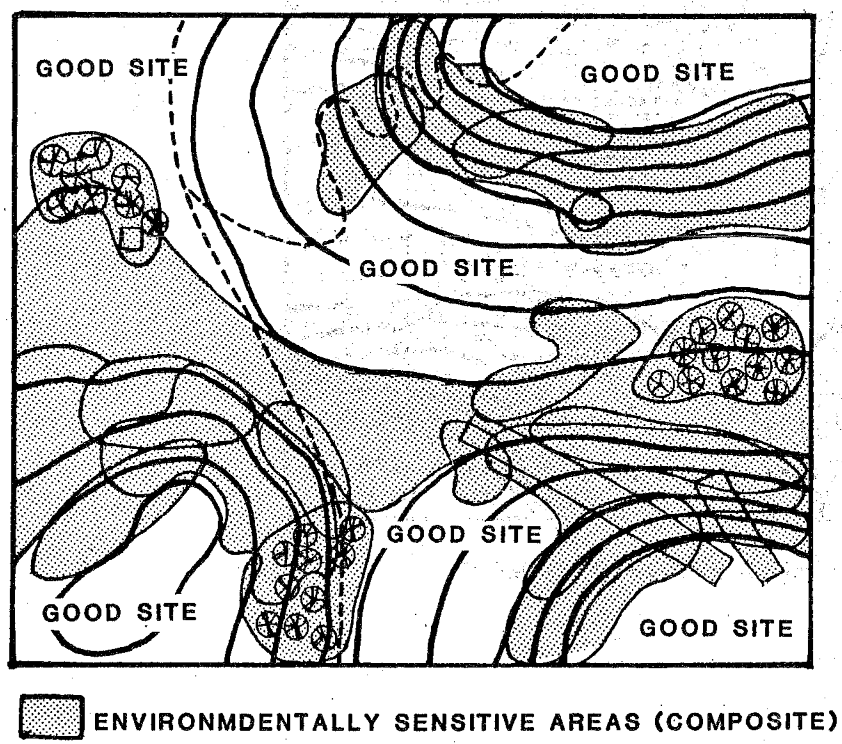


Procedure 3. <u>Develop a composite drawing showing the major opportunities and constraints for development on the site. At this point some weighing of the relative environmental costs and benefits must take place.</u>

° Indicate areas which are inappropriate for development.

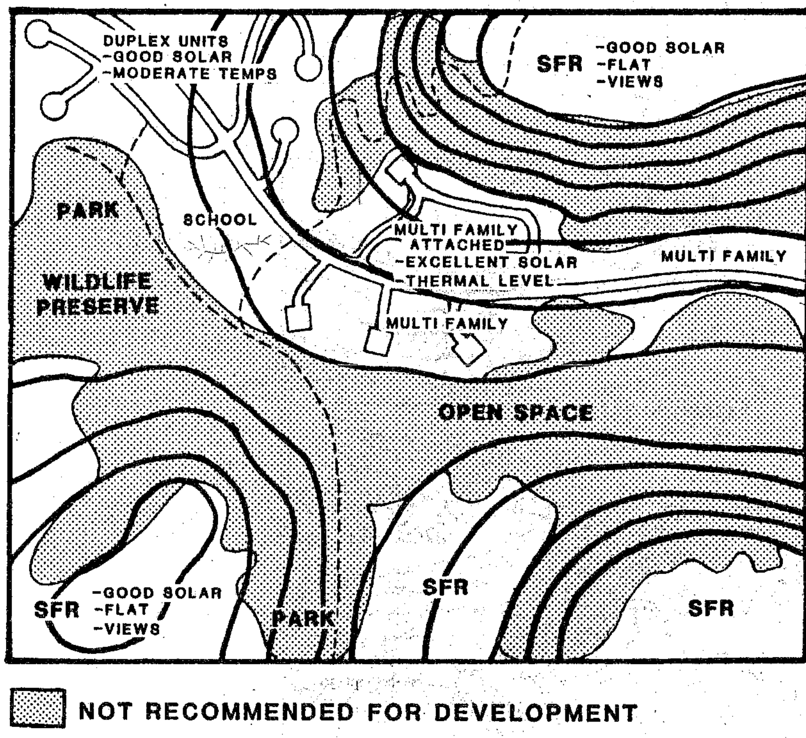
° Indicate areas which have good development potential based on identified opportunities.

(FIGURE G)



Procedure 4. Prepare preliminary development proposals consistent with the major constraints and opportunities shown on the composite drawing. The preliminary development proposal should identify housing type and density, open space, general traffic circulation and major landscaping.

(FIGURE F)



APPENDIX C

SAN DIEGO CLIMATE DATA

Heating and Cooling Degrees Days for San Diego and Nearby Communities

Station	HDD/YEAR	CDD/YEAR
San Diego	1439	579
Chula Vista	1207	666
El Cajon	1920	763
Escondido	2052	766
La Mesa	1492	632
Point Loma	1860	223

The concept of heating degree days (HDD) provides a convenient method of comparing space heating requirements for different geographic locations throughout the City. It assumes that the interior space of a house will require heating, when the outside temperature drops below 65 degrees Fahrenheit. If the average temperature for a given day is 64 degrees Fahrenheit then the hearing requirement will be one heating degree day. A single day with an average temperature of 55 degrees will be counted as ten heating degree days (65 degrees minus 55 degrees). The number of heating degree days is then added to provide monthly or yearly totals.

Cooling degree days are computed in a similar manner, using the assumption that cooling requirements are incurred when the outside temperature rises above 75 degrees.

It should be noted that heating degrees days and cooling degree days represent only a rough estimate of heating and cooling requirements and are most useful in comparing various locations. One important finding is that heating requirements outweigh cooling requirements for all city locations despite San Diego's mild climate.

Solar Insolation Values for Various Collector Tilt Angles

	9/21	10/21	11/21	12/21	1/21	2/21	3/21	4/21	5/21	6/21	7/21	8/21
Horiz.	1841	1411	1032	874	1015	1411	1811	2192	2466	2490	2451	2179
12	2069	1684	1335	1174	1316	1703	2027	2299	2400	2504	2424	2271
22	2151	1767	1544	1413	1538	1851	2151	2258	2349	2321	2342	2278
32	2185	1972	1731	1595	1716	2012	2191	2198	2181	2105	2179	2171
42	2114	2033	1828	1728	1842	2118	2152	2097	1943	1874	1939	2045
52	2044	2042	1891	1817	1891	2055	2059	1908	1673	1564	1666	1851
62	1883	1956	1897	1852	1908	1976	1894	1660	1375	1239	1342	1590
Vert.	1120	1514	1622	1640	1636	1544	1186	738	339	218	321	659

BTU/ft^2-day 32.7^o Latitude

Solar Insolation is a measure of the received radiation from the sun on a surface held at a fixed angle under a clear atmosphere. The above results are given for near sea level at the latitude of San Diego (32.7 degrees).

(Data compiled by James R. Clinton "Solar Energy Home Use in San Diego").